Listing of Claims

1. (Currently Amended) An apparatus for plating a metal onto a substrate, the apparatus comprising:

a plating cell;

an aperture disposed within said plating cell for delivering a plating fluid onto the plating surface of a work piece; and

a diffuser membrane disposed within said plating cell such that the plating fluid emanating from the aperture must pass through said diffuser membrane before contacting the work piece;

wherein the diffuser membrane is made of a material having a pore size of between about 1 to 200 μm and creates a flow pattern such that the plating fluid exits the diffuser membrane at substantially the same velocity across the entire surface of the diffuser membrane.

2. (Original) The apparatus of claim 1, wherein the plating cell is an electroplating cell.

3. (Original) The apparatus of claim 2, further comprising:

a cathode electrical connection that can connect to the work piece and apply a potential, allowing the work piece to become a cathode; and

an anode electrical connection that can connect to an anode and apply an anodic potential to the anode;

wherein the diffuser membrane is between the anode and the cathode.

4. (Canceled)

5. (Original) The apparatus of claims 4, wherein the diffuser membrane is made of a material having a pore size of between about 5 to 50 μm.

6. (Original) The apparatus of claim 4, wherein the material is a non-conductive microporous material selected from the group consisting of sintered plastic, porous ceramic, or sintered glass.

7. (Original) The apparatus of claim 6, wherein the microporous plastic is selected from the group consisting of polyethylene, polypropylene, polysulfone, polyvylidene diflouride (PVDF), and polytetrafluoroethylene (PTFE).

8. (Original) The apparatus of claim 6, wherein the material is between about 0.2 to 2.5 cm thick.

9. (Original) The apparatus of claim 6, wherein the material is between about 0.5 to 1.0 cm thick.

10. (Original) The apparatus of claim 6, wherein the material has a pore volume of between about 10 and 70 percent.

11. (Original) The apparatus of claim 6, wherein the material has a pore volume of between about 20 and 40 percent.

12. (Currently Amended) ~~The apparatus of claim 3 further comprising~~ An apparatus for plating a metal onto a substrate, the apparatus comprising:

an electroplating cell;

an aperture disposed within said plating cell for delivering a plating fluid onto the plating surface of a work piece;

a diffuser membrane disposed within said plating cell such that the plating fluid emanating from the aperture must pass through said diffuser membrane before contacting the work piece;

a cathode electrical connection that can connect to the work piece and apply a potential, allowing the work piece to become a cathode;

an anode electrical connection that can connect to an anode and apply an anodic potential to the anode;

wherein the diffuser membrane is between the anode and the cathode and creates a flow pattern such that the plating fluid exits the diffuser membrane at substantially the same velocity across the entire surface of the diffuser membrane; and

an anode cup, wherein the anode and the aperture are disposed in said anode cup and the diffuser membrane covers the opening of the anode cup; the anode cup and diffuser membrane defining an anode compartment in the electroplating cell.

13. (Original) The apparatus of claim 12, wherein the total volumetric flow rate of the plating fluid pumped into the anode compartment is between about 3 and 20 liters per minute.

14. (Original) The apparatus of claim 12, wherein the total volumetric flow rate of the plating fluid pumped into the anode compartment is between about 6 and 15 liters per minute.

15. (Original) The apparatus of claim 12, wherein the total volumetric flow rate of the plating fluid pumped into the anode compartment is about 12 liters per minute, when the substrate is a 200 millimeter diameter wafer.

16. (Currently Amended) The apparatus of claim 12, wherein the anode compartment is submerged in an electrolyte bath and the diffuser membrane is planar and tilted by a non-zero tilt angle with respect to a plane defining the surface of the electrolyte in the bath.

17. (Original) The apparatus of claim 16, wherein the tilt angle is between about 2 and 6 degrees from horizontal.

18. (Original) The apparatus of claim 16, wherein the tilt angle is about 5 degrees from horizontal.

19. (Original) The apparatus of claim 16, further comprising a mechanism for holding a planar plating surface of the work piece parallel to the diffuser membrane during plating.

20. (Original) The apparatus of claim 16, further comprising a mechanism for rotating the work piece during plating.

21. (Original) The apparatus of claim 16, further comprising a bubble removal path positioned inside the anode compartment proximate to the inner surface of the diffuser membrane such that bubbles flow along the inner surface of the diffuser membrane and exit the anode compartment through said bubble removal path.

22. (Original) The apparatus of claim 12, wherein the aperture is configured to divert the flow of plating fluid exiting the aperture away from the plating surface of the work piece.

23. (Original) The apparatus of claim 21, wherein the aperture is a mushroom type delivery nozzle.

24. (Original) The apparatus of claim 12, wherein the flow rate across the diffuser membrane surface is at least 0.5 ml/second/cm^2 when exposed to a pressure difference of about 2 psi.

25. (Original) The apparatus of claim 12, wherein the flow rate across the diffuser membrane surface is at least 1.5 ml/second/cm^2 when exposed to a pressure difference of about 2 psi.

26. (Original) The apparatus of claim 12, wherein the diffuser membrane can withstand a pressure difference of at least 5 psi.

27. (Original) The apparatus of claim 12, wherein the diffuser membrane can withstand a pressure difference of at least 10 psi.

28. (Original) The apparatus of claim 12, further comprising a porous transport barrier, disposed between the anode and the diffuser membrane, defining an anode chamber, between the anode and the porous transport barrier, within the anode compartment and a diffuser chamber, between the diffuser membrane and the porous transport barrier, within the anode compartment; wherein the porous transport barrier allows migration of ionic species, including metal ions, between the anode chamber and diffuser chamber, while substantially preventing non-ionic organic bath additives from entering into the anode chamber.

29. (Original) The apparatus of claim 28, wherein the transport barrier comprises a material selected from the group consisting of porous glasses, porous ceramics, silica areogels, organic aerogels, porous polymeric materials, and filter membranes.

30. (Original) The apparatus of claim 28, wherein the transport barrier comprises sintered polyethylene or sintered polypropylene.

31. (Original) The apparatus of claim 28, further comprising a carbon filter layer that is substantially coextensive with the transport barrier, which carbon filter layer can filter non-ionic organic bath additives from plating fluid passing through the transport barrier to the anode chamber.

32. (Original) The apparatus of claim 28, wherein the aperture diverts a portion of the total plating fluid flow into the anode chamber and the remaining portion into the diffuser chamber.

33. (Original) The apparatus of claim 32, wherein the portion of the total plating fluid flow diverted into the anode chamber is between about 5 and 20 percent.

34. (Original) The apparatus of claim 33, wherein the portion of the total plating fluid flow diverted into the anode chamber is about 10 percent.

35. (Original) The apparatus of claim 28, wherein the anode compartment is submerged in an electrolyte bath and the transport barrier has at least one portion of its surface tilted with respect to a plane defining the surface of the electrolyte in the bath.

36. (Original) The apparatus of claim 35, further comprising at least one bubble removal path positioned inside the anode chamber proximate to the inner surface of the transport barrier,

such that bubbles flow along the inner surface of the transport barrier and exit the anode chamber through said at least one bubble removal path..

37. (Original) The apparatus of claim 28, further comprising an isolation valve for protecting against the plating fluid level dropping below the diffuser membrane and the transport barrier.

38. (Currently Amended) A method for providing a substantially uniform flow of a plating fluid to the plating surface of a wafer during plating, the method comprising:

providing a compartment fitted with a diffuser membrane <u>made of a material having a pore size of between about 1 to 200 μm</u>;

pumping the plating fluid into said compartment such that the plating fluid exits the compartment through the diffuser membrane at substantially the same velocity across the entire surface of the diffuser membrane; and

holding the plating surface of the wafer in close proximity to the diffuser membrane during plating.

39. (Canceled)

40. (Original) The method of claim 39, wherein the diffuser membrane is made of a material having a pore size of between about 5 to 50 μm.

41. (Original) The method of claim 40, wherein the material is a microporous material selected from the group consisting of sintered plastics, ceramics, and sintered glasses.

42. (Original) The method of claim 41, wherein the microporous plastic is selected from the group consisting of polyethylene, polypropylene, polysulfone, polyvylidene diflouride (PVDF), and polytetrafluoroethylene (PTFE).

43. (Original) The method of claim 41, wherein the material is between about 0.2 to 2.5 cm thick.

44. (Original) The method of claim 41, wherein the material is between about 0.5 to 1.0 cm thick.

45. (Original) The method of claim 41, wherein the material has a pore volume of between about 10 and 70 percent.

46. (Original) The method of claim 41, wherein the material has a pore volume of between about 20 and 40 percent.

47. (Original) The method of claim 41, wherein the total volumetric flow rate of the plating fluid is between about 3 and 20 liters per minute.

48. (Original) The method of claim 41, wherein the total volumetric flow rate of the plating fluid is between about 6 and 15 liters per minute.

49. (Original) The method of claim 41, wherein the total volumetric flow rate of the plating fluid is about 12 liters per minute for a 200 millimeter diameter wafer.

50. (Original) The method claim 41, wherein the compartment is an anode compartment and electroplating is the plating method used.

51. (Original) The method of claim 50, wherein the anode compartment is submerged in a plating bath and the diffuser membrane is tilted with respect to a plane defining the surface of the plating fluid in the plating bath.

52. (Original) The method of claim 51, wherein the plating surface of the wafer is held parallel to the diffuser membrane during plating.

53. (Original) The method of claim 52, wherein the wafer is rotated during plating.

54. (Original) The method of claim 53, wherein the wafer is rotated at between about 25 and 250 rpm.

55. (Original) The method of claim 53, wherein the wafer is rotated at between about 50 and 150 rpm.

56. (Original) The method of claim 54, wherein the flow velocity across the diffuser membrane is between about 0.2 and 1.4 cm/sec.

57. (Original) The method of claim 55, wherein the flow velocity across the diffuser membrane is between about 0.4 and 0.9 cm/sec.

58. (Original) The method of claim 38, wherein holding the plating surface of the wafer in close proximity to the diffuser membrane means having a separation distance between the plating surface and the diffuser membrane of between about 5 and 60 millimeters.

59. (Original) The method of claim 58, wherein the separation distance is between about 10 and 40 millimeters.

60. (Original) The method of claim 38, wherein holding the plating surface of the wafer in close proximity to the diffuser membrane means having a separation distance between the

plating surface and the diffuser membrane that measures between about $1/40^{th}$ and $1/5^{th}$ of the diameter of the wafer.